U.S. DEPARTMENT OF COMMERCE
National Technical Information Service

PB-270 711

Motorcycle Tailpipe Dilution CVS Study

Environmental Protection Agency, Ann Arbor, Mich

Oct 76

EPA-460/3-76-039

PB 270 711

Standards Development and Technical Support Report

Motorcycle Tailpipe Dilution CVS Study

October 1976

Notice

Technical support reports for regulatory action do not necessarily represent the final EPA decision on regulatory issues. They are intended to present a technical analysis of an issue and conclusions and/or recommendations resulting from the assumptions and constraints of that analysis. Agency policy constraints or data received subsequent to the date of release of this report may alter the conclusions reached. Readers are cautioned to seek the latest analysis from EPA before using the information contained herein.

Standards Development and Support Branch
Emission Control Technology Division
Office of Mobile Source Air Pollution Control
Office of Air and Waste Management
U.S. Environmental Protection Agency

Reproduced by
NATIONAL TECHNICAL
INFORMATION SERVICE
U.S. Department of Commerce
Springfield, VA 22161

BIBLIOGRAPHIC DATA SHEET	1. Report No.	2.	3. Recipient's Accession No.
4. Title and Subtitle: Motorcycle Tailpipe Dilution CVS Study			5. Report Date: October 1976
7. Author(s): Standards Development and Support Branch			8. Performing Organization Rept. No. MC 76-09
9. Performing Organization Name and Address: Standards Development and Support Branch Emission Control Technology Division U.S. Environmental Protection Agency Ann Arbor, Michigan 48105			10. Project/Task/Work Unit No. 11. Contract/Grant No.
12. Sponsoring Organization Name and Address: Same as Box 9			13. Type of Report & Period Covered: Technical Support Report 14.

15. Supplementary Notes

16. Abstracts

A new exhaust dilution system has recently been designed and built for use in motorcycle testing at EPA. Prior to being put into use, it was necessary to determine if the new system was capable of meeting the requirements as described in §86.509(b) and (c) of the motorcycle regulations. The purpose of this report is to describe the findings of that study. Conclusions: Static pressure variations at the tailpipe of the test vehicle remain between -0.14 and -0.15kPa of the static pressure variations at the tailpipe during the urban driving schedule. This is well within the closest tolerance specified in the motorcycle regulations; Virtually no water condensation was observed in the exhaust dilution system after multiple testing of a large motorcycle over the Urban Dynamometer Driving Schedule.

17. Key Words and Document Analysis. 17a. Descriptors

Air pollution
Motorcycles
Exhaust gases
Exhaust systems
Tests

17b. Identifiers/Open-Ended Terms

Exhaust dilution system
Test procedure

17c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
Release Unlimited	UNCLASSIFIED	7
	20. Security Class (This Page) UNCLASSIFIED	22. Price $4.00

FORM NTIS-35 (REV. 3-72) ENDORSED BY ANSI AND UNESCO. THIS FORM MAY BE REPRODUCED USCOMM-DC 14952-P72

Abstract

The motorcycle exhaust dilution system has been evaluated for water condensation and its ability to maintain static pressure variations within ± 0.25 kPa as measured at the tailpipe of a test vehicle. After multiple runs over the Urban Dynamometer Driving Schedule with a large displacement motorcycle, virtually no water condensation was observed in the system and the static pressure variations ranged from -0.14 to -0.13 kPa.

Prepared by

William M. Hawkins
Project Manager
Motorcycle Regulations

Charles Gray, Jr.
Branch Chief,
Standards Development and
Support Branch

John P. McKay
Division Director,
Emission Control
Technology Division

Introduction

In the process of diluting motorcycle exhaust prior to entry into the Constant Volume Sampler (CVS), two requirements must be met as described in §86.309 (b) and (c) of the motorcycle regulations: 1) static pressure variations at the tailpipe of a vehicle tested by EPA must be capable of remaining within ± 0.25 kPa of the static pressure variations measured during a dynamometer driving cycle with no connection to the tailpipe, and 2) the location of the dilution air inlet shall be placed and the flow capacity of the CVS shall be large enough to virtually eliminate water condensation in the system. A new exhaust dilution system has recently been designed and built for use in motorcycle testing at EPA. Prior to being put into use, it was necessary to determine if the new system was capable of meeting the above requirements. The purpose of this report is to describe the findings of that study.

Summary and Conclusions

--Static pressure variations at the tailpipe of the test vehicle remain within -0.14 and -0.13 kPa of the static pressure variations at the tailpipe during the urban driving schedule. This is well within the closest tolerance specified in the motorcycle regulations.

--Virtually no water condensation was observed in the exhaust dilution system after multiple testing of a large motorcycle over the Urban Dynamometer Driving Schedule.

Discussion

The objective of this study was to evaluate the exhaust dilution system presently used in the motorcycle test cell. This evaluation stemmed from two requirements as specified in the motorcycle regulations regarding the dilution system.

A) Sections 86.309(b)(1) and (c)(1) state that the static pressure variations at the tailpipe of the vehicle tested by EPA must be capable of remaining within ± 0.25 kPa of the static pressure variations measured during a dynamometer driving cycle with no connection to the tailpipe.

B) Sections 86.309(b)(4) and C(4) state that the location of the dilution air inlet shall be placed and the flow capacity of the CVS shall be large enough to virtually eliminate water condensation in the system.

A. Static Pressure Variation

The static pressure variations were evaluated using a 15 cm. long stainless steel tube connected directly to the test vehicle's tailpipe. The test vehicle was a two-stroke, three cylinder, Suzuki GT-750 displacing 738cc.

Both the positive displacement pump constant volume sampler (PDP-CVS) and the critical flow venturi constant volume sampler (CFV-CVS) were used. The exhaust dilution system is depicted in Figure 1.

Figure 1 - Exhaust Dilution System

The static pressure at the tailpipe of the test vehicle with no connection (other than the short measurement tube) ranged from 0.00 kPa at idle to a maximum of 40.02 kPa during high RPM acceleration. Initially during this evaluation the static pressure at idle was about -0.29 kPa which is outside of the desired minimum static pressure of -0.25 kPa. After modifying the flow path in the dilution box, with the tailpipe connected to the dilution system and the CVS pump turned on, the static pressure ranged from -0.14 kPa at idle to -0.11 kPa during high RPM acceleration. Therefore, the difference in static pressure variations ranged from -0.14 to -0.13 kPa which is well within the $\pm$ 0.25 kPa tolerance that EPA must be capable of maintaining. This is summarized in the following table.

Difference in static pressure (in kPa) between operation with and without exhaust system connections

	Necessary capability of EPA	At idle with restricted flow path	During Driving schedule after modifying flow path	Without motorcycle connected and after modifying flow path
PDP-CVS	$\pm$ 0.25	- 0.29	- 0.14 to - 0.13	- 0.14
CFV-CVS	$\pm$ 0.25	- 0.29	- 0.14 to - 0.13	- 0.14

This table also includes a static pressure reading with the CVS pump operating and with the motorcycle tailpipe connection point blocked. This was done because the static pressures in the system were below atmospheric and by introducing exhaust volume into the system, this acted to reduce this differences. This procedure was necessary to simulate a small displacement motorcycle with a very low exhaust volume flow rate. Even under such conditions the exhaust dilution system is within the desired static pressure tolerance.

B. Water Condensation

Using the test vehicle, five sequential urban driving schedules were performed. Though water condensation was observed in the tailpipe connectors, virtually no condensation was observed in the exhaust dilution system or in the cyclonic separator of the CFV-CVS.

Recommendation

When an exhaust dilution system is designed for use in motorcycle testing, it is recommended that the design consider both the potential for water to condense in the system and flow restrictions which could significantly reduce the static pressure as measured at a test vehicle's tailpipe.

After installation of a new dilution system, pressure tests should be performed to assure compliance with the requirements specified in §86.509 of the motorcycle regulations.